Adaptive mesh refinement versus subgrid friction interpolation in simulations of Antarctic ice dynamics – D.F. Martin, E.Ng (LBNL), et al.

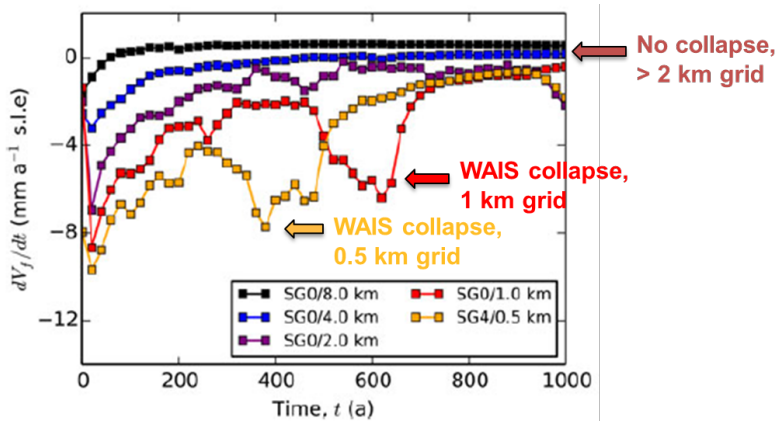
Objectives

- The 2007 & 2013 Intergovernmental Panel on Climate Change (IPCC) reports highlighted the need for better projections of the Antarctic contribution to sea-level rise (SLR).
- The West Antarctic Ice Sheet (WAIS) is vulnerable to marine forcing from warm-water incursion into subshelf cavities, causing melting and thinning of ice shelves and weakening or eliminating the buttressing exerted on feeder ice streams. The result is accelerated ice loss and increased SLR.
- Theory and modeling suggest that ice-sheet models require very fine (sub-km) resolution to correctly model these effects.
- Use extreme melt forcing scenario to examine resolution requirements for millennial-scale whole-continent simulations.

Impact

- First fully-resolved whole-continent millennial-scale Antarctic simulations to evaluate resolution requirements. Broadly useful as a method to ensure confidence in model results.
- The Berkeley Adaptive Mesh Refinement (AMR) ice sheet model (BISICLES) fully resolves dynamically important regions like grounding lines.
- Use of a basic subgrid-scale friction interpolation scheme results in factor-of-two reduction in resolution requirements.
- Under-resolved simulations consistently underestimate SLR contributions. Even moderate under-resolution results in erroneous predictions of timing and mechanisms of WAIS collapse, while severe under-resolution results in missing WAIS collapse entirely.

Antarctic rate of contribution to Sea Level Rise



Simulations conducted at the National Energy Research Scientific Computing Center (NERSC)

FY 2016 Accomplishments

- First application of BISICLES, a state-of-the-art AMR ice sheet model, to millennial-scale whole-continent projections of Antarctic response to extreme climate forcing.
- AMR allows for full resolution of dynamically changing grounding lines in regional- and continental-scale simulations.

"Adaptive mesh refinement versus subgrid friction interpolation in simulations of Antarctic Ice Dynamics", Cornford, Martin, Lee, Payne, Ng, *Annals of Glaciology*, 57 (73), DOI: https://doi.org/10.1017/aog.2016.13, 2016